Defence and Civil Institute of Environmental Medicine

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6 THE DCIEM "ON LINE" SERIAL CHOICE REACTION TIMER (SCRT)

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ABSTRACT

An apparatus was developed to measure the psychomotor performance, namely, serial choice reaction time and movement time, of human subjects during exposure to various environmental stresses, such as, hypoxia and inert gas narcosis. It consists of a stimulus-response module (SRM) which is comprised of geometrically arranged sets of light emitting diodes (LEDs) and corresponding response buttons for extinguishing the LEDs as they are randomly lit. The apparatus is constructed in such a way that it permits visual stimulus intensity, the number of response alternatives and the average movement distance to be varied. A PDP 11/04 computer is used to control the apparatus and to record and analyze subjects' responses.

INTRODUCTION AND BACKGROUND

The purpose of this report is to describe, in detail, the 'on-line' serial choice reaction time apparatus (SCRT) which was developed at the Defence and Civil Institute of Environmental Medicine (DCIEM), Downsview, Canada. The SCRT was developed to assess the effects of environmental stressors, such as inert gas narcosis (Fowler, Ackles and Wright, 1977) and hypoxia (Fowler, 1979), on human psychomotor performance. The development of the DCIEM SCRT consisted of a redesign by Fowler et al. (1977) of the serial choice reaction time apparatus employed by other investigators (Poulton, 1970) so that parameters affecting performance components of visual perception, decision capacity and movement time could be controlled, and thereby enable an analysis of the effects of environmental stressors on each of these components and any interactions between them.

The present version of the SCRT consists of a square panel with 3, 4 or 5 light emitting diodes (LEDs) arranged in geometric patterns - a triangle, a square, or a pentagon. The perimeter of each of these shapes is adjustable. Adjacent to each LED is a round disc which, when tapped with a stylus by the subject, extinguishes the LED when it is lit. As one LED is extinguished another LED is lit at random, and this LED in turn must be extinguished and so on continuously for an experimentally determined period of time. The time interval between the lighting of a LED and the tapping of the appropriate disc to extinguish the LED is

recorded, on-line, on a PDP 11/04 computer. The computer also records errors, that is the tapping of an inappropriate disc, and controls the random presentation fo stimuli as well as other parameters of the task. When a trial is completed on the apparatus, a complete record and statistical analysis (see APPENDIX C for sample results) of the trial is made available to the experimenter almost emmediately.

An information processing approach to the analysis of psychomotor performance suggests that psychomotor performance may be conceptualized as the outcome of information being sequentially processed by three "black boxes": (1) sensory/perceptual process, (2) decision capacity (choice reaction time), and (3) motor control (movement time). In order to assess the effects of stressors on the first "black box", the visual perception processing stage, the intensity of the LEDs of the SCRT is adjustable to two levels. It is well known (Woodworth and Schlosberg, 1960, chapt. 2) that bright stimuli yield faster reaction times than dimmer stimuli. Thus, simple changes in reaction time or differential changes in reaction time differences due to stimulus intensity would enable an inference to be made whether the action of a stressor on reaction times was localized at the visual processing stage.

The second processing stage, decision capacity, may also be effected by environmental stress; it is investigated by varying the number of alternatives that the subject must choose between in order to make a response on the SCRT. The relationship between reaction time and the number

of alternative responses was first studied by Hick (1952) and subsequently, in greater detail, by Hyman (1953). An extensive review of this subject matter was made by Welford (1968). The Hick-Hyman Law is stated as follows:

$$\text{Choice reaction time} = a + b \log_2 n$$

where a = simple reaction time

b = a constant of the decision mechanism

n = the number of response alternatives

When there are no alternatives in the task, and $n = 1$, the second term of the equation is equal to zero because no decision is required and therefore choice reaction time is equal to simple reaction time.

The effect of environmental stressors on the motor control component of psychomotor performance is investigated using the SCRT by manipulating the distances between the response buttons. The relationship between movement distance, the accuracy of a movement and the time to make the movement was first established by Fitts (1954). Fitts Law is stated as follows:

$$\text{Movement time} = a + b \log_2 2A/W$$

where a and b system constants

W = target width

A = the distance between the centers of the 2 targets

It is believed that movement from one target to another has two components (Welford, 1968). The first component is known as the initial impulse, during which acceleration from the first target toward the

second target takes place. Welford (1968) suggested that the constant 'a' represents the time spent on the first target programming the initial impulse. The second component of movement is current control which consists of deceleration and a series of visually medicated fine corrections toward the second target. Welford (1968) also postulated that the constant 'b' represents the information processing rate of some central processing mechanism responsible for current control. It is apparent that stress induced decrements in movement time could be further dissected to yield information as to the component of the movement which is affected by the stressor.

THE APPARATUS

The SCRT consists of two major components: (1) the stimulus-response module (SRM), and (2) a PDP 11/04 minicomputer manufactured by Digital Equipment Corporation (Maynard, Massachusetts, U.S.A.) and associated hardware and software (Figure 1a).

The SRM has three components: (1) the cabinet and its support; (2) three configuration templates which allow the number of alternative responses and the distance between the response buttons to be varied, and (3) five stimulus response trays each containing a stimulus light and its corresponding button.

The wooden cabinet of the SRM is painted non reflective flat black on all interior and exterior surfaces (Figure 1, dimensions of cabinet).

The configuration templates fit intc the open top of the cabinet so that they may be quickly and easily interchanged. When in position, each template forms the top surface of the cabinet and is also painted black. Each template measures 61 cm x 61 cm and has an appropriate number of slots (3, 4 or 5) cut into it to accommodate the stimulus-response trays.

The cabinet support which is attached to the center of the bottom of the cabinet, consists of 3.8 cm O.D. steel tubing fitted into 3.8 I.D. steel tubing. A metal hose clamp fitted around the first tube enables the support height adjustment. A frame, with four castors, affixed to the bottom of the second tube makes the entire unit movable.

The stimulus-response trays are constructed of 20 gauge aluminum and are painted flat black (Figure 2, tray dimensions). Mounted in each tray is a red light emitting diode (LED), (Fairchild, serial number FLV560) and a pushbutton (Microswitch, model PK 85022). The head of the button projects 1.5 cm above the surface of the tray and has a 2 cm diameter, 20 gauge aluminum, unpainted disc cemented to it. Electrical wires from the pushbutton and LED pass from underneath a tray to a terminal bar in the bottom of the SRM cabinet. A multiconductor cable relays the electrical impulses from the terminal bar to the computer.

Each of the configuration templates has slots cut into it in order to accommodate either 3, 4 or 5 stimulus response trays. The trays can be positioned in the slots so that the mean distance from center to

center of the button heads will be between 10 and 40 cm (Figures 3, 4 and 5). A wooden, rubber-tipped stylus (30 cm long x 0.75 cm diameter) is used to strike the pushbuttons.

The luminance of each LED is individually controlled by the interposition in the LED power circuit of a single-pole double throw switch, with different resistors on each side of the switch, mounted inside the SRM cabinet.

The second component of the SCRT is a PDP 11/04 minicomputer. The associated hardware consists of three pieces of equipment: (1) a dual diskette drive unit; (2) a console terminal (Decwriter II; Digital Equipment Corporation, Maynard, Massachusetts, U.S.A.) and (3) a Compact System Controller (Digital Equipment of Canada) frame which provides the interface between the computer and the SRM. The diskette unit operates with 2 diskettes. One diskette contains two main programs: RTE, which controls the SRM and RTANAL, which provides statistical analysis of the data collected on the second diskette. The following sections give a brief, general description of the RTE and RTANAL programs (for details of content and operation of RTE and RTANAL see APPENDICES A and B respectively).

THE "RTE" PROGRAM

RTE is a program designed to run the SCRT. The basic functions of this program are:

a) the selection (at random) and lighting of the LEDs described previously.

b) the monitoring of the time taken to press the target pushbutton associated with the selected LED and also the number of times an incorrect pushbutton was pressed during that time.

c) The recording of the results collected by (b).

RTE runs under the RT-11 single job monitor (Version 3) on a PDP-11/04 minicomputer equipped with:

a) at least 20K words of memory

b) one dual diskette drive

c) a console terminal

d) a Compact System Controller containing (i) a W7406 dual accumulator-timer module, (ii) a M1015 digital input module and (iii) a M1008 digitial output module.

RTE is divided into three sections:

1) a startup section which communicates with the operator to collect information concerning the operation of the program,

2) the experiment section which runs the experiment using the Compact System Controller

to operate the LEDs, pushbuttons and timer required by the experiment, and

3) a shutdown section which performs the "bookkeeping" and Compact Systems Controller shutdown associated with the end of the experiment.

(For details of RTE see APPENDIX A).

THE "RTANAL" PROGRAM

RTANAL is a program designed to perform analysis of data files generated by the RTE program. The analysis package is divided into two sections: a program 'SETUP' which can prepare command files specifying analysis instructions, and a program 'RTANAL' which performs the analysis, accepting either these command files or direct keyboard input. These programs are designed to run under Version 3 of the RT-11 operating system, and are described in detail in APPENDIX B.

CONCLUSIONS

The DCIEM 'on-line' serial choice reaction timer (SCRT) has been used successfully "in house" to assess the psychomotor performance of human subjects under experimental conditions of narcosis and hypoxia (APPENDIX C, Fowler et al., 1977 and Fowler, 1979). The SCRT permits a fairly detailed examination of human psychomotor performance via an analysis of three controlled task factors and their interactions (see APPENDIX C and Fowler (1979) for representative analyses) and represents

a significant improvement on earlier reaction time apparati. It has been demonstrated by Fowler (1979) that, subjects having practiced to asymptotic performance on the task, stable measures of performance may be obtained using the SCRT when trials are as short as two minutes duration; contaminating factors such as fatigue and subject motivation are therefore avoided.

A major advantage of the SCRT apparatus is the ease with which it can be modified to suit various experimental paradigms. For example, it can be modified easily to be equivalent to typical reaction time apparati with from 1 to 5 stimulus-response pairs with either fixed or variable inter-trial intervals.

Another major advantage of the SCRT apparatus is that a complete record and analysis of each trial is available to the experimeter almost immediately after trial completion. This capability permits significant economy of both experimenter's and subject's time.

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APPENDIX A

DETAILS OF THE RTE PROGRAM

I. INTRODUCTION

In the startup section of the RTE, communication is made with the operator to collect information concerning the operation of the program. This communication with the operator is done through a dialogue. The computer asks questions in a standard format and they are answered in a standard way. In the following description of the dialogue, the symbol (c/r) means carriage return.

The kind of reply expected of the operator for a question is usually indicated in the question. A question will be accompanied by one of three symbols in square brackets. This symbol indicates what type of answer is expected. The three symbols are {S}, Y/N, {#}.

The symbol {S} indicates that the expected reply is a string of letters and/or numbers followed by (c/r).

The Y/N symbol indicates that only replies allowed for this question are:

> Y (c/r)--meaning "YES"
>
> N (c/r)--meaning "NO"
>
> (c/r)--meaning "accept the default" (see 'defaults' below).

The {#}symbol indicates that only acceptable replies are: (a) --a number followed by (c/r) and (b)--(c/r for the default reply (see "defaults below).

Defaults:

Some questions have replies already attached to them which do not have to be typed--these are called "defaults". If no answer is typed (a carriage return only) then the default is accepted by the program as the operator's answer to that question. A question which has a default reply is accompanied by that default reply in brackets as (Y)--meaning "Y" is the default reply.

Stopping the dialogue and starting over

During the dialogue, the operator may type CRTRL/P (hold the CONTROL key down and strike 'P') followed by (c/r). The program restarts the dialogue at the beginning.

II. LOADING THE PROGRAM

The diskette containing the program is placed in the left-hand drive of the computer. Another diskette (for data storage) is placed in the right-hand unit.

When the RT-11 system is loaded and the date is entered, the program is started by typing: RUN RTE. When the program starts, it will begin the dialogue.

III. RUNNING THE PROGRAM

The experiment dialogue

When the program is loaded, the following statement is typed:

REACTION TIMER EXPERIMENT VERSION Yx-y

The following questions area then asked:

a) DATA FILE NAME: {S}

The operator types a name for the data file that contains the data from this experiment run. The name may be up to six characters long, must be composed of letters and numbers ONLY and start with a letter.

Example:

DATA FILE NAME: {S} RUN1 (c/r)

The name of the data file will be RUN1.

b) TIME TO RUN IN SECONDS # (360):

The operator types the length of the run. If the operator simply types (c/r), the experiment will run for 360 seconds. The minimum time for a run is 1 second; the maximum length is determined by the record space available and/or the endurance of the subject.

c) NUMBER OF CHOICES {#} (5) =

The operator types the number of choices allowed in the experiment followed by (c/r). If the operator simply types a (c/r), 5 choices will be used.

d) TYPE UP TO THREE LINES OF COMMENTS

The operator is allowed to type up to three lines of text followed by two carriage returns ((c/r) (d/r)). This text appears in the "User Header Area" of the data file (see DATA FORMAT below).

When the comments have all been typed, the experiment starts running.

Running the experiment:

The program types: RUN BEGINS. At the same time, all of the LEDs

become lit. When the subject is ready, a button press (any button) starts the actual equipment run. Normally the run continues until the amount of time specified by the operator (in the dialogue) has elapsed. Should an error occur, the run stops and the program attempts to recover the data (see ERRORS below).

To stop the run manually:

Type CTRL/P (hold the CONTROL key down and strike 'P') followed by (c/r). The run stops, the data will be stored and the program restarts with the dialogue.

Experiment completion, data storge:

When a run ends (even prematurely), the program stores the data on the diskette in the right hand drive (unit 1). The program confirms that this has happended by typing: RUN COMPLETES DATA STORED IN FILE nnnnnn. DAT. The "nnnnn" is filled in by the program with the data file name the operator gave to the program in the dialogue.

The program then normally goes back to the beginning of the dialogue to start another run. This procedure is called "completion".

IV. ERRORS

The following section describes the various error messages,their meanings and what to do about them. In most cases, the program will go to completion after typing the error message and then stop. The computer will type a dot indicating that the program is no longer running.

a) PLEASE ENTER THE DATE

After typing this message, the program exits and the keyboard monitor types a dot. The operator has forgotten to enter the system date. The system date is entered and the program reloaded.

b) NO REPONSE FROM SUBJECT DETECTED

Either something has happened to the subject or there has been a failure in the pushbutton box and its associated hardware. If the subject is all right, then a breakdown has occurred in the SRM. All of the data collected to this point will have been stored by the program.

c) DISKETTE FAILURE WRITING DATA

Something has broken down while the program was attempting to store data. The program will save as much data as possible.

d) NO MORE ROOM ON DISKETTE

The program cannot store any more data than it has so far in the run---there is simply no place to put it. All of the data collected to this point will be stored. The only way to continue is to restart with an empty diskette.

e) FAILURE TO CLOSE DATA FILE

The final process of storing the data has failed. The data are on the diskette but they ae no easily accessible. The program will type:

DATA FILE NAME WAS nnnnnn

STARTING BLOCK OF FILE WAS xxxxxx

LAST DATA WRITTEN ON FILE BLOCK yyyyyy

and perhaps the line: HEADER STORED ON DXO AS RTDTAH.TMP

! ! ! SAVE THESE MESSAGES ! ! !

The data file must be restricted and merged with the stored header.

f) DATA FILE ALREADY EXISTS AS xxxxxx

A data file of the specified name already exists. The program asks for a new data file name: DATA FILE NAME {S}? When the new data file name is entered, the experiment proceeds normally.

V. DATA RECORD FORMAT

Data are stored as keyed, fixed length sequential records. Each record is 8 bytes in length.

The layout of the data record is shown in Table 1

TABLE 1

ENTRY	SIZE	LAYOUT REMARKS
KEY	2 bytes	1 if correct response record
		2 if incorrect response record
RTIME	2 bytes	time to respond in milliseconds
REXP	1 byte	expected response
RGIVEN	1 byte	received response
ITI	2 bytes	intertrial interval (seconds)

VI. USER HEADER AREA

The user header area is used to store the parameters of the experiment. The layout of this area is shown in Table 2.

TABLE 2

ENTRY	SIZE	REMARKS
LAGSWITCH	1 byte	-1 if lag; 0 if no lag
LAGAMT	1 byte	amount of lag (0-5)
SERSW	1 byte	-1 if serial; 0 if nonserial
DLYAMT	1 byte	amount of delay (seconds + 2 seconds
CHOICES	1 byte	number of choices (1-5)
ABOSW	1 byte	0 if run completed normally -1 if run cmpleted prematurely
TIME	4 bytes	specified run time in ticks
SPARE	8 bytes	reserved
COMM	248 bytes	reserved for comment lines

APPENDIX B

DETAILS OF THE RTANAL PROGRAM

I. RTANAL

In order to run RTANAL, the diskette containing the load module 'RTANAL.SAV' should be placed in the left-hand drive (DXO:) and the data diskette should be in the right-hand drive (DX1:). Prior to running RTANAL, the user must enter a system date in standard RT-11 form; if the sytem has no line printer, the terminal (TT:) must be assigned to device 6 via. ASS TT6 if immediate printed output is required. If no command file has been prepared (via SETUP or otherwise) the user should type R RTANAL which will start the analysis program. A dialogue is initiated with the user in order to determine the type of analysis desired; the first question asks for the data subset to be analyzed:

```
ENTER ANALYSIS TYPE
C = CORRECT RESPONSES
F = FIRST RESPONSES
B = CORRECT FIRST RESPONSES
FOLLOW WITH "I" FOR INDIVIDUAL BUTTON ANALYSES
OR WITH "L" FOR SHORT/LONG RESPONSE ANALYSES
DESIRED ANALYSIS:
```

to which the proper response is one of the set

(blank), C, F, B, CI, FI, BI, CL, FL. BL .

If the response is blank, RTANAL exits. A response specifying 'C' will select the correct (and therefore last) response from each trial in the run as the datum to be used; if 'F' is specified, the first response

from each trial will be used as the datum; and 'B' will specify that only trials in which the first response is correct are to be used in the analysis. If the user response contains the character 'I' in second position, the trials are partitioned into groups, one per button used as the stimulus, and the groups are analysed separately according to the analysis type specifed as the first character. If the character 'L' is specified in second position the trials are again partitioned, this time into groups corresponding to the distance between the current button and the previous button. This analysis option is intended for use with experimental layouts composed of four buttons arranged at the vertices of a square or five buttons positioned at the vertices of a regular pentagon; in the case of three buttons at the vertices of an equilateral triangle, all inter-button distances are of course identical, so that this option is meaningless. The user is cautioned against assuming an orderly progression of button numbers in the pentagonal case; a sample run will reveal the actual numbering scheme. The 'L' option will usually be specified for an analysis of correct first responses, i.e., with specification 'BL'. A response other than those given above causes RTANAL to exit.

The next question asks for the kind of output desired:

```
ENTER OUTPUT TYPES
D = DESCRIPTIVE STATISTICS
H = HISTOGRAM
P = PRINT RAW DATA
DESIRED OUTPUT:
```

to which the proper response is either blank or some combination of the characters 'D', 'H', and 'P'; all combinations are legal and the characters may be in any order.

The descriptive statistics provided are:

a) the number of responses used in the analysis

b) the mean reaction time in milliseconds

c) the variance

d) the standard deviation

e) the standard error of the mean

f) the minimum

g) the lower quartile (only for 4 or more responses)

h) the median

i) the upper quartile (only for 4 or more responses)

j) the maximum

k) the semiinterquartile range (only for 4 or more responses)

l) the skewness of the empirical distribution

m) the kurtosis of the empirical distribution

n) the number of responses greater than 1500 msec.

o) the number of responses greater than 3000 msec.

If fewer than two response are in the set to be analyzed, no statistics are computed and RTANAL types:

INSUFFICIENT DATA FOR ANALYSIS.

If a histogram is requested, it will be plotted horizontally on the

page with class limits at the left, followed by the number in the cell, and lastly the histogram bar. Because of the finite width of the page, a scale factor is given at the top of the graph (e.g., '*=2' indicating that each histogram point represents 2 counts).

A request to print the raw data (intended originally as a debugging tool) will result in a list of trial responses as represented by record number, an asterisk ('*') if the response is included in the analysis, the record key, the reaction time in msec, and the stimulus and response button numbers.

RTANAL has the capacity to split a data file sequentially and analyze each part separately. To accomplish this, the user is asked for the length of each part by:

TIME SLICE IN SEC:

to which he may respond with a blank (carriage return only) in which case the entire data file is analyzed as a unit, or he may respond with a desired duration in seconds, in which case the file is divided timewise into slices of the given length for separate analyses. The division takes place after an integral number of trials in all cases; consequently, the actual time slices will fluctuate in size, and the last slice may be considerably shorter than the others. This feature operates independently of the individual button and long-short analysis features; it can be combined, as desired, with either of them.

If a histogram was requested, RTANAL asks next for the data size and starting value:

BIN WIDTH IN MSEC:

INITIAL VALUE IN MSEC:

to which the proper responses should be obvious. The histogram can be cancelled at this point by supplying a zero or negative bin width.

The final item in the dialogue is the name of the file containing the data:

TYPE FILE NAME:

to which is expected a one-to-six character string as the response. RTANAL interprets this as a data file name to which it suffixes .DAT as the extension; it then attempts to open and read the file on DX1. If it is successful, RTANAL prints several lines of information contained on the file header block; the analysis proceeds to completion, and RTANAL returns to request another file name, to which the same specifications will be applied. Input of a blank file name will cause the dialogue to be restarted, at which point a new set of analysis specifications may be entered.

If an error occurs during the open, read, or close phases of file access, RTANAL will inform the user. All errors cause program termination and will abort the analysis run except for one:

FILE XXXXXX NOT ON DX1

where 'XXXXXX' is the file name entered, in which case a new file name will be requested and RTANAL will continue. If no system date has been entered (the RMSRT routines called by RTANAL refuse to work unless they know the date) RTANAL will type:

STOP--NO SYSTEM DATE ENTERED.

Any other error will result in a message of the form RMSOPR ERROR or RMSRD ERROR or RMSCLO ERROR followed by an error number (in octal), the

meaning of which may be ascertained by reference to the RMSRT manual. RTANAL exits in each of these cases.

II. SETUP

The dialogue described in Section I can be set up as a command file to be used as input to RTANAL for automatic file processing, thereby relieving the user of the necessity of being present throughout a lengthy analysis session. The program SETUP is designed to create a command file through the dialogue described in Section I; this command file may then be used as input to RTANAL. The diskette containing the load module SETUP.SAV should be present on DX0, and the data diskette should be present as DX1. To start SETUP, the user types:

R SETUP

and the dialogue begins as already described. Input is terminated by entering a blank file name. The command file will be created on DX1 as 'FILES.LIS' and can be invoked through a second command file 'RTANAL.COM' (which should be present on DX0)- by typing:

@RTANAL @DX1:FILES.LIS

which will execute the desired analysis.

If it is desired to anlayze all of the files on DX1, the process of creating FILES.LIS can be considerably shortened; a file containing the names of all files on DX1 can be created on DX0 by using the RT-11 system program DIR as follows:

DIR/OUTPUT:DX1.DIR/FAST/COLUMS:1 DX1:*.DAT

This file can then be edited to remove unwanted information:

R EDIT

*EBDX1.DIRRBKGFilesOA2KB G.DAT$-4J$KV $EX$$

The file DX1.BAK can then be deleted and SETUP can be run with no file names specified, creating FILES.LIS on DX1, which can then be combined with the edited DX1.DIR using PIP:

R PIP

*DX1:FILES.LIS=DX1:FILES.LIS,DX0:DX1.DIR/U

Finally, DX1.DIR should be deleted from DX0 if it will not be reused.

APPENDIX C

SAMPLE RESULTS

ANALYSIS OF FILE E8T4H

```
WRIGHT J HI LITE SAT = 65%

                    CORRECT FIRST RESPONSES

HISTOGRAM * = 3 RESPONSES

TIME(RANGE-MSEC)

    0 -  100      0
  100 -  150      0
  150 -  200      0
  200 -  250      2     *
  250 -  300    108     **************************
  300 -  350     93     **********************
  350 -  400     44     ***********
  400 -  450     17     ******
  450 -  500      5     **
  500 -  550      6     **
  550 -  600     11     ****
  600 -  650     13     *****
  650 -  700      9     ***
  700 -  750      2     *
  750 -  800      3     *
  800 -  850      1     *
  850 -  900      0
  900 -  950      1     *
  950 - 1000      4     **
 1000 - 1050      0
 1050 - 1100      0
 1100 - 1150      0
 1150 - 1200      1     *

SUMMARY STATISTICS:
     320 RESPONSES
     MEAN       =       378.0
     VARIANCE   =     21909.4
     STD DEV    =       148.0
     SEM        =         8.3
     MINIMUM    =       246.0
```

MAXIMUM	=	1197.0
SIQR	=	46.6
SKEWNESS	=	5.2
KURTOSIS	=	5.9

0 RESPONSES > 1500
0 RESPONSES > 3000

ANALYSIS OF FILE E8T3L

WRIGHT J LO LITE SAT = 65%

CORRECT FIRST RESPONSES

HISTOGRAM * = 3 RESPONSES

TIME (RANGE-MSEC)

0 - 100	0	
100 - 150	0	
150 - 200	0	
250 - 300	112	******************************
300 - 350	96	**************************
350 - 400	33	***********
400 - 450	28	*******
450 - 500	12	****
500 - 550	6	**
550 - 600	4	**
600 - 650	9	***
650 - 700	6	**
700 - 750	2	*
750 - 800	2	*
800 - 850	4	**
850 - 900	0	
900 - 950	1	*
950 - 1000	0	
1000 - 1050	2	*
1050 - 1100	1	*
1100 - 1150	1	*
1150 - 1200	0	
1200 - 1250	0	
1250 - 1300	1	

SUMMARY STATISTICS:

320 RESPONSES

MEAN	=	375.4
VARIANCE	=	22814.2
STD DEV	=	151.0
SEM	=	8.4
MINIMUM	=	259.0
LOWER Q	=	292.0
MEDIAN	=	321.0
UPPER Q	=	393.0
MAXIMUM	=	1253.0

SIQR	=	50.9
SKEWNESS	=	8.0
KURTOSIS	=	9.4
0 RESPONSES >		1500
0 RESPONSES >		3000

Figure 1 a: View of the components of the Serial Choice Reaction Timer (SCRT) - the stimulus-response module (SRM), PDP11/04 mincomputer and console terminal.

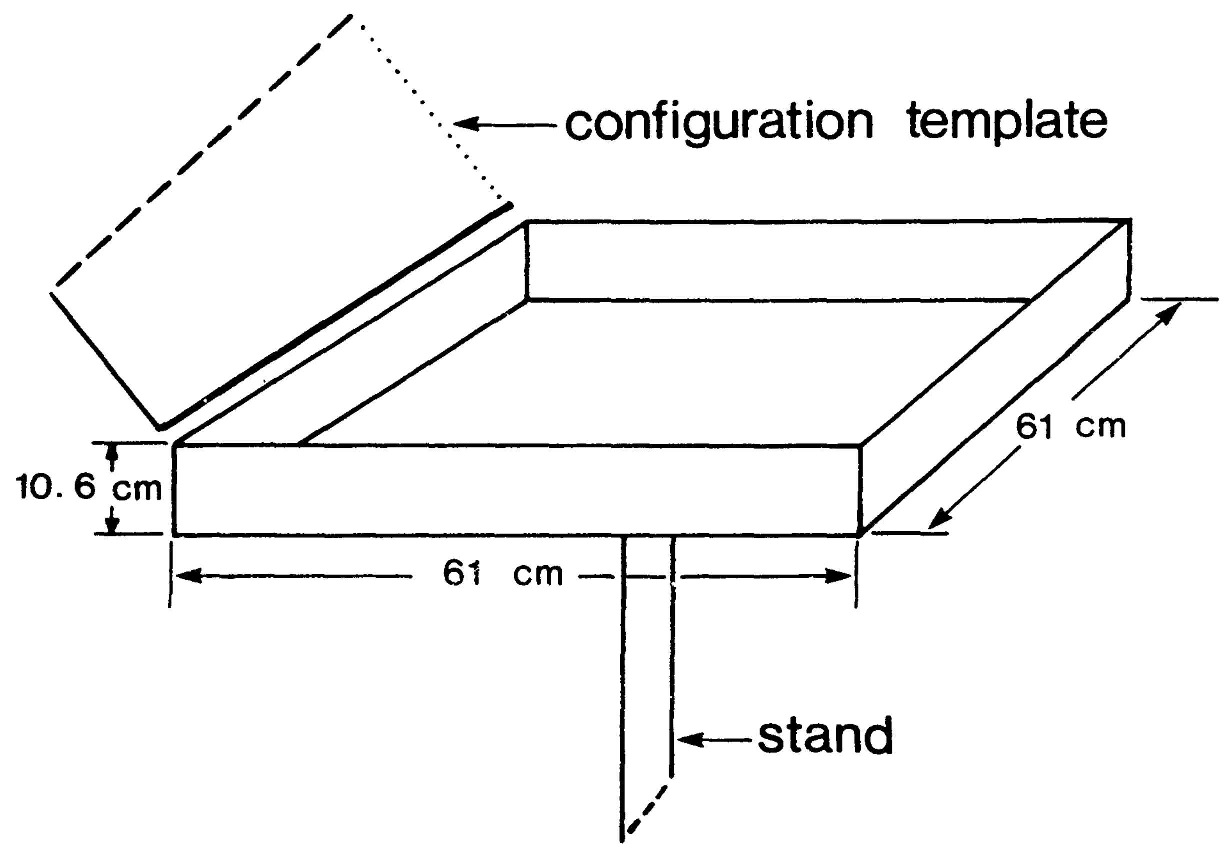


Figure 1. Dimensions of Stimulus Response Module (SRM).

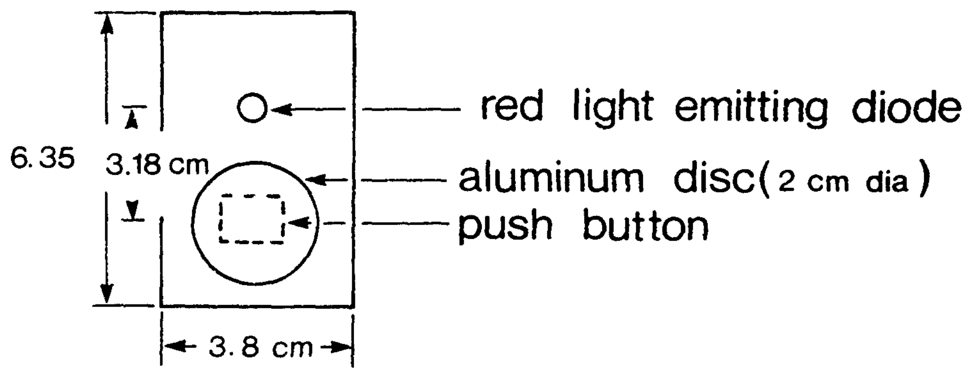
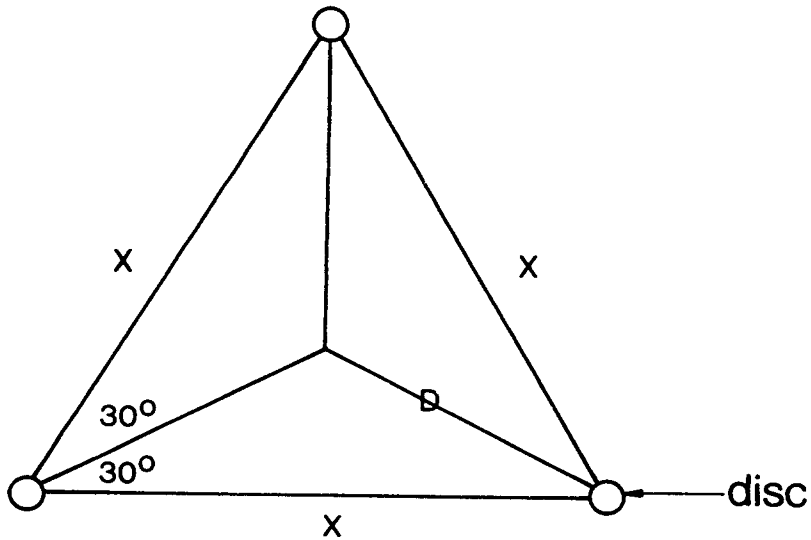


Figure 2 Stimulus Response Tray

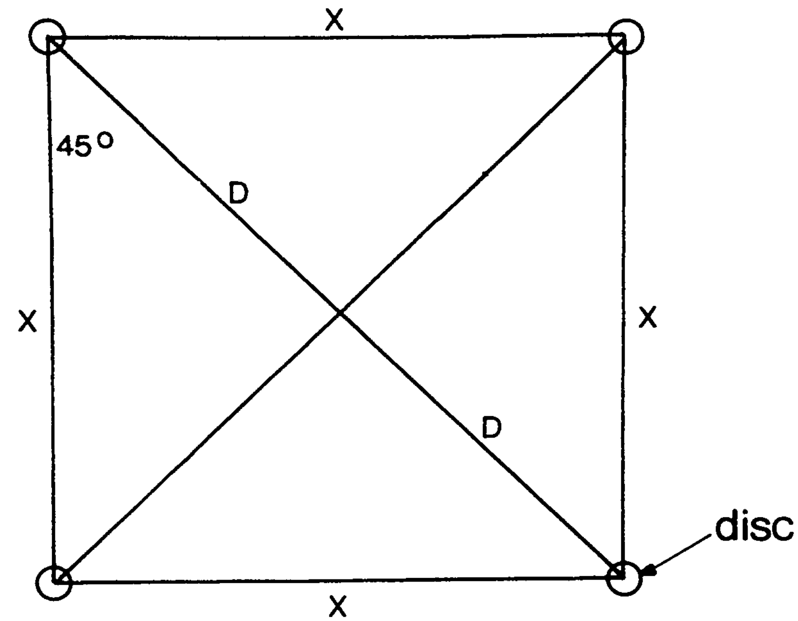


note: line D represents a 2.54 cm wide slot in which the stimulus-response trays move.

Condition	Average Distance	X*	D**
1	10 cm	10 cm	5.7 cm
2	20 cm	20 cm	11.5 cm
3	40 cm	40 cm	23.0 cm

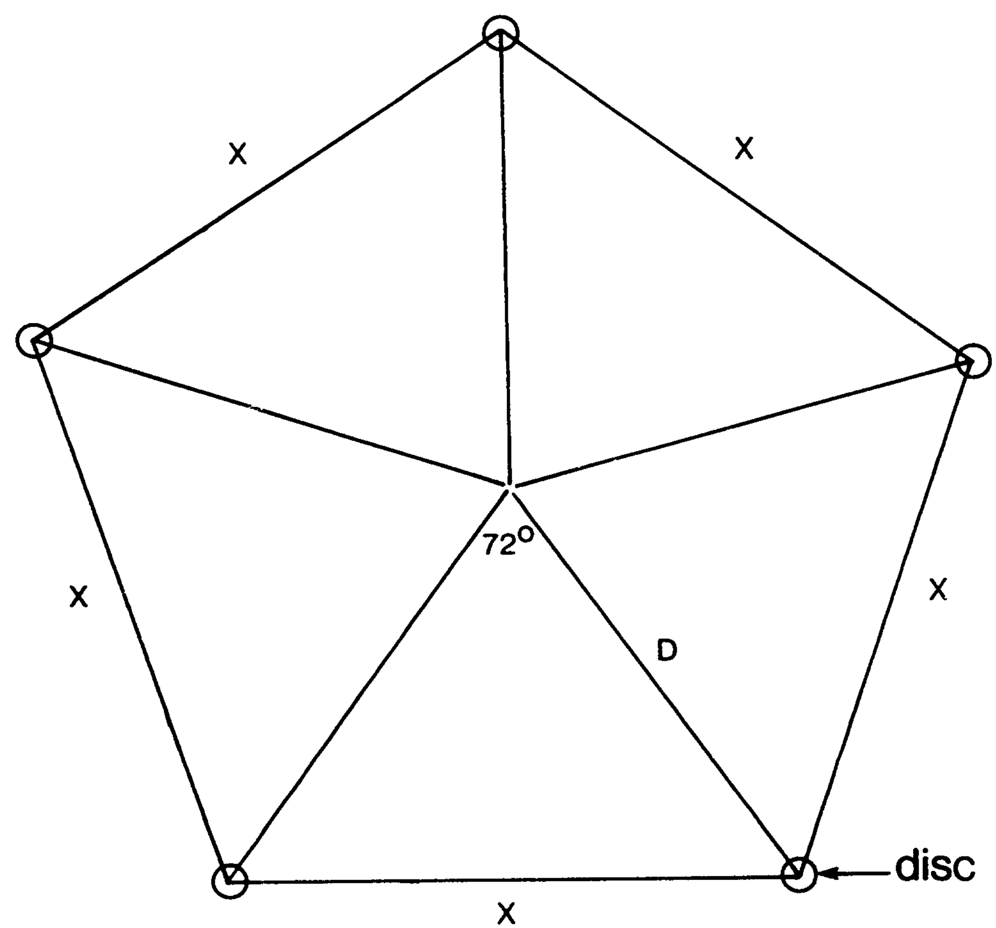
*Distance between adjacent buttons.
**Distance from centre of button to centre of template.

Figure 3. Dimensions for the three distances for the two choice configuration template.



Condition	Average Distance	X	D
4	10	8.7 cm	6.2 cm
5	20	17.5 cm	12.4 cm
6	40	35.1 cm	24.8 cm

Figure 4. Dimensions for the three distances for the three choice configuration template.



Condition	Average Distance	X	D
7	10	7.6 cm	6.4 cm
8	20	15.2 cm	12.9 cm
9	40	30.5 cm	25.9 cm

Figure 5. Dimensions for the three distances for the four choice configuration template.